GEOLOGICAL SURVEY OF OHIO
COLUMBUS 10
JOHN H. MELVIN, State Geologist

Report of Investigations No. 3

Areal Extent and Thickness of the Salt Deposits of Ohio

By
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Reprinted from the OHIO JOURNAL OF SCIENCE,
Vol. XLVII, No. 6, pp. 225-239, 1947

AREAL EXTENT AND THICKNESS OF THE SALT DEPOSITS OF OHIO[1]

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INTRODUCTION

Beds of rock salt occur in Ohio in rocks of the Salina formation of the upper Silurian. Since 1889 salt has been manufactured commercially from these beds by pumping fresh water into wells drilled to the salt beds and repumping the brine to the surface, where it is processed. Salt, which is one of the basic raw materials of the chemical industry, is a commercial resource of great and increasing value to Ohio.[2] [3] [4]

In order to furnish information that may be useful to operators desiring suitable locations for salt plants, a regional study has been made to determine the western limits of the occurrence of beds of salt in Ohio, the total thickness of salt beds within the area of occurrence, and the depth to the top of the highest salt bed in the section at any place. The study is based on an examination of the records of salt beds contained in well logs in the files of the U. S. Geological Survey and on the results of examinations of samples by R. E. Lamborn of the Geological Survey of Ohio. No attempt is made in this report to discuss the general stratigraphic correlations of the Silurian salt sequence of Ohio to the salt-bearing Salina formation of Cayuga (Silurian) age of other areas, or to suggest the possible origin and manner of deposition of the salt.

ACKNOWLEDGMENTS

The drillers' records of wells used in compiling the salt data were obtained from the Ohio Division of Mines and the Geological Department of The Ohio Fuel Gas Company. The cooperation of these organizations is gratefully acknowledged. The writer gratefully acknowledges the assistance and kind criticism of Dr. George White and Mr. R. E. Lamborn of the Geological Survey of Ohio. Mr. Lamborn supplied the records of sample wells which he had examined, together with much assistance in the calculation of the estimated original thicknesses of the several salt beds. Messrs. H. D. Miser, C. H. Dane, and R. E. Van Alstine of the U. S. Geological Survey kindly read and criticized the manuscript. The writer wishes to thank Mrs. Violet M. Massarelli for her assistance in compiling the data on which the report was based and for drafting the accompanying maps.

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[1]Published by permission of the Director, U. S. Geological Survey, and the State Geologist of Ohio.

[2]Hildreth, S. P. Salt Springs: Early History of Salt Manufacture in Ohio, [reprint] in Ohio's Mineral Resources, III. Salt: Ohio State Univ. Eng. Exper. Sta. Circ. no. 47, vol. XIV, no. 2, pp. 1–12, July, 1945.

[3]Harris, W. R., and Corell, E. J. Industrial Development of Salt Manufacture in Ohio, in Ohio's Mineral Resources, III. Salt: Ohio State Univ. Eng. Exper. Sta. Circ. no. 47, vol. XIV, no. 2, pp. 13–19, July, 1945.

[4]Gambs, G. C., and White, G. W. Ohio's Mineral Resources, III. Salt reserves (Third in a series on salt): Ohio State Univ. Eng. Exper. Sta. Circ. no. 49, vol. XV, no. 3, pp. 1–22, September, 1946.

DATA UPON WHICH THE STUDY WAS BASED

The data on which this study was based were derived chiefly from an examination of the records of 3,555 wells drilled for oil or gas to the horizon of the Clinton sand, which lies below the salt series in east-central Ohio. In eastern Ohio along the Ohio-Pennsylvania border few wells have been drilled through the salt series, and drilling information is thus available at only widely scattered points. The following table shows the number of well records examined:

NUMBER OF WELL RECORDS, TO THE CLINTON SAND, USED IN COMPILING SALT DATA

County	From U. S. Geological Survey Files		From Sample Records by R. E. Lamborn†
	Total Number	Number which Record Salt	
Ashtabula	37	16	3
Belmont	1	1	1
Carroll	4	4	1
Columbiana	5	4	.....
Cuyahoga	20	13	.....
Geauga	12	8	.....
Harrison	12	10	2
*Holmes	702	12	.....
Lake	19	14	1
Mahoning	6	2	1
Medina	210	54	.....
Portage	16	12	.....
Stark	794	755	2
Summit	245	182	.....
Trumbull	13	11	1
*Tuscarawas	244	184	3
Washington	1	1	.....
*Wayne	1,214	113	.....
Totals	3,555	1,396	15

*Salt is not present west of a line which passes through the county.
†See logs at end of report.

The table shows that no salt is recorded in many drillers' records of wells within the area of salt deposition in Ohio. Salt may not have been present in some of the wells, but it is doubtful that salt beds are absent over extensive areas. Probably most of the wells passed through beds of salt, but the driller failed to observe these beds because they are thin, or, if thick, are interbedded with dolomite, anhydrite, or shale. The salt cuttings in a well being drilled may go into solution in the water which is used in drilling or become mixed with mud, and thus may escape notice when bailed from the well. The driller probably would record salt when the contact between a hard bed, such as dolomite, above and thick salt bed below was sharp, for the bit would have a tendency to penetrate more easily when it reached the salt Some drillers recorded from one to four beds of salt; in the same area others recorded the top of the uppermost salt bed and the bottom of the lowest salt bed and thus logged as salt the entire sequence of rocks, which in reality included also beds of dolomite, limestone, anhydrite, and shale.

The determination of the thickness of salt beds from an examination of samples taken through the salt series is difficult, for much of the salt is dissolved by the water used in drilling. Usually samples are taken at intervals of 6 to 10 feet, and

if only enough salt is present to saturate the water the samples may consist mostly of dolomite and anhydrite together with a few fragments of salt or salt crusts which are deposited upon the cuttings as the water evaporates. The beds represented by such a sample may thus consist mainly of salt, the dolomite and anhydrite being present only as thin beds. However, the presence of salt and an estimation of the thickness of the salt beds can be much more accurately determined from well samples than from the driller's log.

OCCURRENCE OF THE SALT

The oldest salt beds throughout the region of southern New York, western Pennsylvania, northern West Virginia, eastern Ohio, Michigan, and southwestern Ontario were deposited in local isolated basins. For example, the oldest salt beds in Ohio were deposited in the deeper part of a basin in Portage and Columbiana Counties. As deposition of salt continued, each basin increased in size until near the end of Salina time the basins became connected and salt was deposited throughout the region. Over a broad area in eastern Ohio some of the salt beds, although apparently nearly continuous by correlation based on position in the section, are probably not strictly equivalent in time of deposition.

The salt beds of the Ohio salt basin occur in the central part of a thick section of limestones and dolomites. The drillers call this sequence of beds the Big Lime, because the drilling characteristics of limestone and dolomite are not sufficiently different to distinguish one from the other and because the muds bailed from wells drilling in this sequence of rocks have a gray color similar to lime muds. Stratigraphically in Ohio the Big Lime includes from the top down, the Delaware limestone, Columbus limestone, and Detroit River dolomite (all Devonian); the Bass Island dolomite (Silurian); the "bed of rock salt with some shale and interbedded dolomite, all of which probably represent the Salina group"[5] (Silurian) and the dolomites of the Niagara limestone (Silurian). The limestones and dolomites have been described from outcrops west of the salt area, but the salt beds are known only from subsurface information. In eastern Ohio along the Pennsylvania border some of the subsurface beds are correlated with, and named after, beds that crop out in New York and Pennsylvania. Thus, the term "Onondaga limestone" is used in eastern Ohio to describe the Devonian limestone of the Big Lime above the salt. On paleontological evidence the Onondaga limestone at outcrops in New York and Pennsylvania is apparently equivalent only to the Columbus limestone.

The amount of shale in the salt series varies from place to place. Although much shale is recorded in the salt beds by the drillers, Lamborn found from his sample examination that much of the so-called shale is either very thin bedded argillaceous dolomite or limestone. Sample records are too few in the salt basin to indicate the area in which the greatest amounts of dolomite, anhydrite, and shale are interbedded with the salt, but in general these other rocks appear to increase in proportion eastward.

WESTERN LIMIT OF SALT DEPOSITION

The western limit of salt deposition in Ohio is shown by the zero thickness line on the maps (figs. 1, 2). In Medina, Wayne, and Holmes Counties, the location of this line is based upon the examination of the records of many wells. In these counties the zero line was drawn at places where more than 75 per cent of the well logs contained no record of salt. In Lorain and Tuscarawas Counties the zero line is less accurately determined because fewer well records were available. South of Tuscarawas County in Guernsey, Noble, and Washington Counties where very little information is available, the zero line is only approximate.

[5]Lamborn, R. E. Data on the thickness and character of certain sedimentary series in Ohio: Ohio Jour. Sci., vol. 34, no. 6, pp. 353-354, November, 1934.

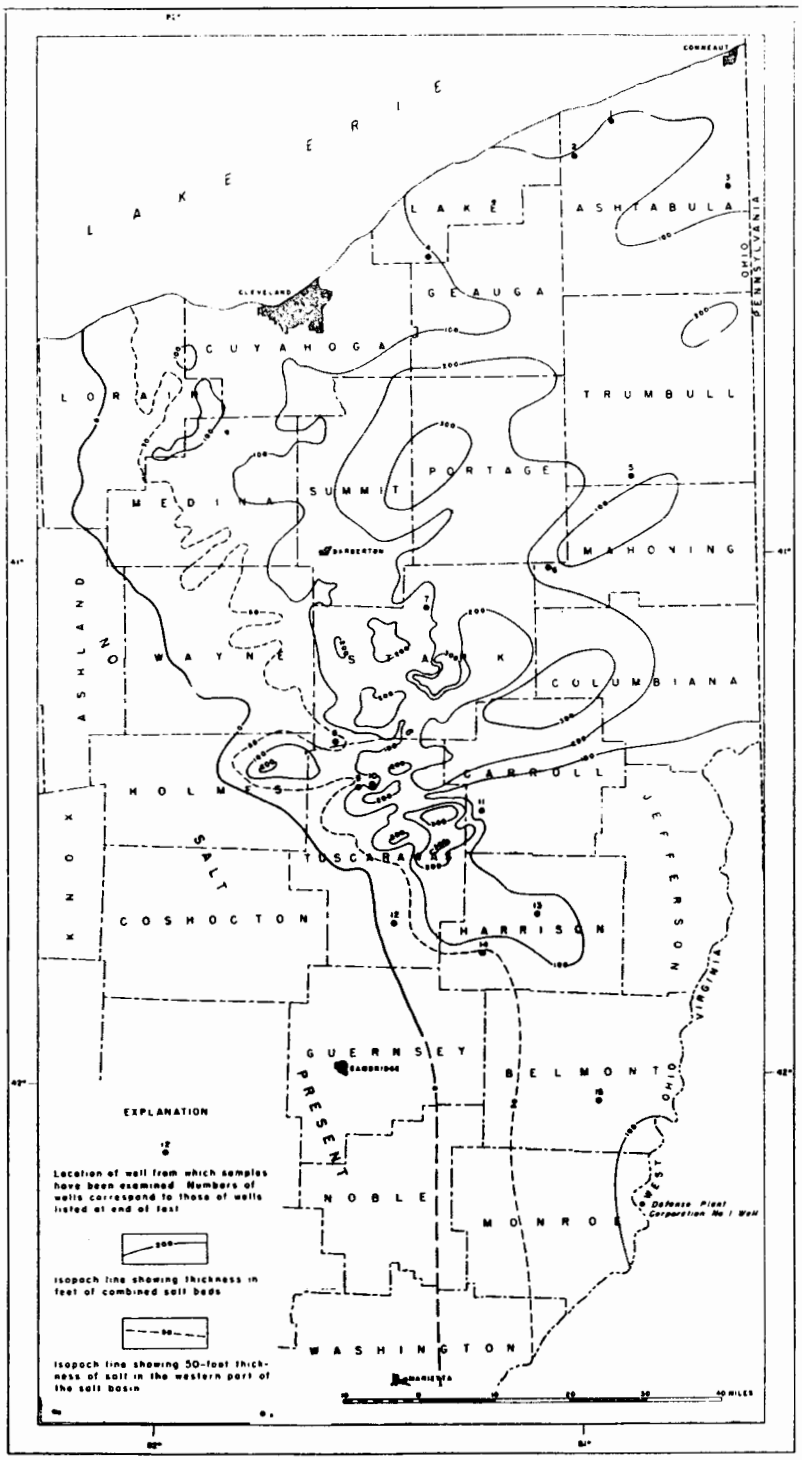

FIGURE 1. Salt thickness map. Shows the combined thickness of all known beds of salt within the Ohio salt basin.

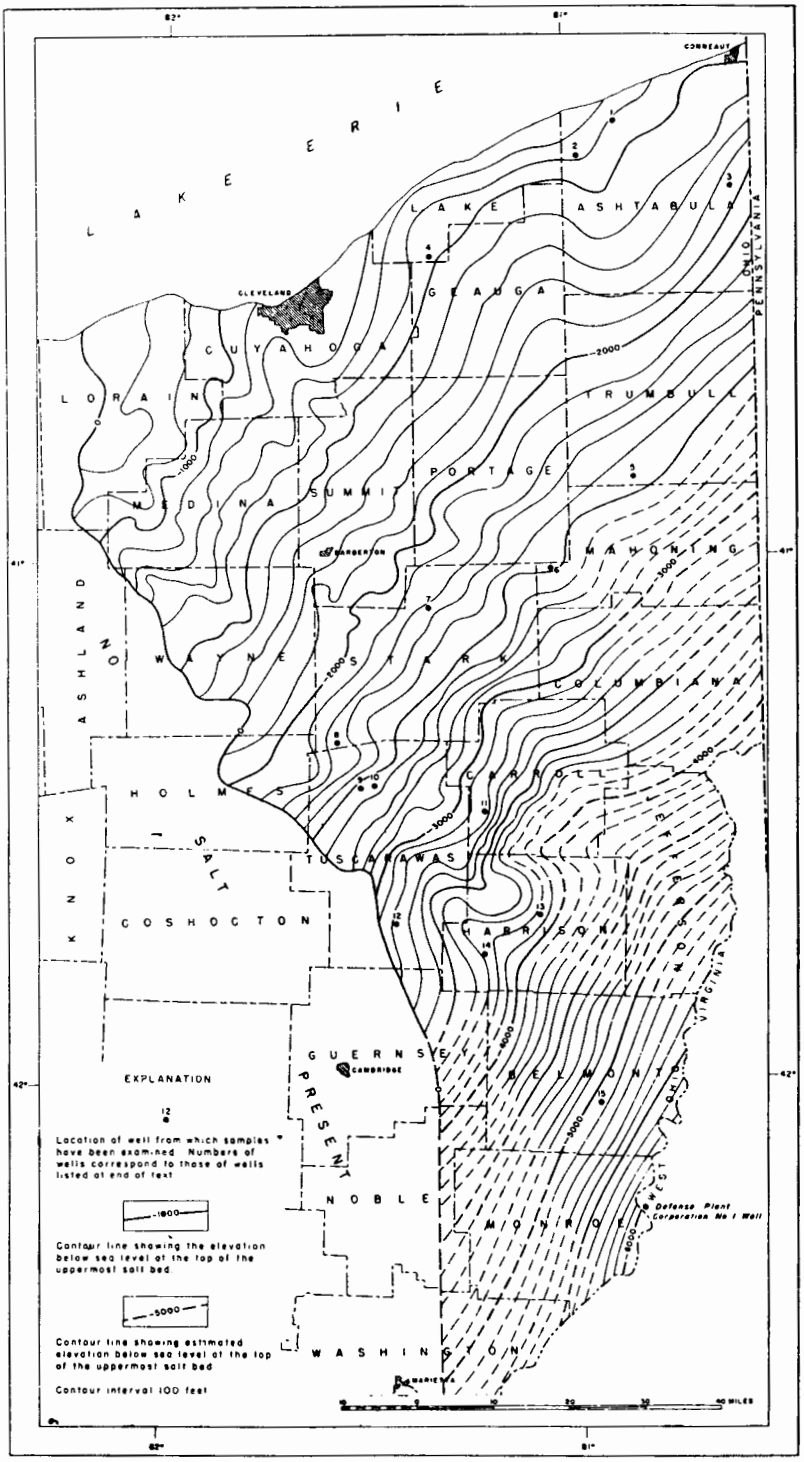

FIGURE 2. Map of eastern Ohio showing depth of the uppermost salt bed below sea level.

In the northwestern part of the salt basin, especially in Medina and Wayne Counties, the many well records show a gradual but irregular thinning of the salt beds from east to west. For example, in eastern Medina County the records show a total thickness of 100 feet or more of salt, but near the zero line the salt beds thin to between 5 and 20 feet. Possibly if sufficient sample logs were available, the zero line would show more irregularities, for probably the thin salt beds were deposited in embayments or shallow salt pans along the edge of the salt basin.

THICKNESS AND NUMBER OF THE SALT BEDS

The thicknesses of all known beds of salt within the salt basin have been combined on the thickness map (fig. 1). In the western part of the area shown on the map, in western Lorain and western Medina Counties, the driller usually records a single bed of salt; in Cuyahoga, eastern Medina, eastern Lorain, Summit, Portage, Geauga, Stark, and Tuscarawas Counties from two to four beds are recorded in many wells. The recording of but one thick salt bed in any but the westernmost of these counties is questionable, for probably in many of the wells shaly dolomite or anhydrite is interbedded with the salt. In Ashtabula, Lake, Trumbull, and Mahoning Counties, drillers record from two to five beds; in one well in Trumbull County eight beds of salt were recorded.

Whether the salt in the western part of the basin was deposited as a single bed which splits into several beds eastward is not determinable. Locally a bed may split, but for the most part the salt probably occurs as lenses deposited at different times and hence now lies at different levels within the salt section. For example, in western Portage and western Columbiana Counties an eastward thinning occurs in the rocks lying between the lowest recorded salt bed and the "Newburg," a brine-filled zone of porous dolomite which lies below the salt series and about 200 feet above the base of the Big Lime. The thinning of these rocks suggests that the salt beds to the east are older than salt beds to the west whose vertical distance to the "Newburg" is greater.

DEPTH TO TOP OF THE UPPERMOST SALT

The map (fig. 2) shows by means of contour lines the approximate elevations, below sea level, of the top of the salt within the salt-bearing area. The map is not strictly a structure map, for the top of the uppermost salt encountered in any well may not be at the same stratigraphic level as the top of the uppermost salt in wells in other areas. The difference in stratigraphic level between the top of the salt beds in widely separated wells may be as much as 100 feet. Locally, however, the top of the salt between adjacent wells in any area is probably accurate within half of a contour interval.

The shallowest depth at which salt may be obtained appears to be in an area in Lorain County that includes Sheffield and Avon Townships. There the depth from the surface to the top of the uppermost salt bed ranges from 1,275 to 1,350 feet. From this place the salt beds dip southeastward, about 30 feet per mile, to Barberton, in Norton Township, Summit County, where in the test well of the Columbia Chemical Division of the Pittsburgh Plate Glass Company, the uppermost salt bed lies 2,751 feet below the surface[6] or 1,706 feet below sea level. Fifty-four miles southeast of Barberton the Texas Company's E. A. Mizer No. 1 well in Stock Township, Harrison County, found the uppermost salt at 4,767 feet below the surface or 3,846 feet below sea level. Although wells drilled below the salt are uncommon in southeastern Ohio, the few available records show that the salt dips southeasterly between Barberton and the Ohio River at a fairly uniform

[6]Stauffer, C. R. The geological section at the limestone mine, Barberton, Ohio: Am. Jour. Sci., vol. 242, p. 259, May, 1944.

rate of about 50 feet per mile, for Martens[7] records the top of the salt at 6,724 feet below the surface or 6,035 feet below sea level in the Defense Plant Corporation's No. 1 well in Franklin district, Marshall County, West Virginia.

THICKNESS OF BEDS BETWEEN TOP OF BIG LIME AND TOP OF UPPERMOST SALT BED

According to Martens[8] the interval between the top of the Onondaga (Big Lime) and the top of the uppermost salt bed is apparently highly variable in Pennsylvania and West Virginia, and the irregularity of this interval is particularly noticeable in western Pennsylvania. Cross sections also show variations in the vertical distance between the top of the Onondaga limestone and the top of the uppermost salt bed in Ohio, but the variations apparently are not as great as in Pennsylvania. The greatest vertical distances between the top of the Big Lime and the top of the uppermost salt bed in Ohio are in Columbiana and Portage Counties; these distances decrease markedly to the west and to the northeast.

Lamborn[9] has shown that the Big Lime sequence in Ohio is thickest in a belt along the eastern edge of the State, for he notes: "The thinnest part of the Big Lime as recorded in well records is found in Scioto and Pike counties where it measures about 300 feet. It thickens rapidly to the east and northeast, however, for it reaches its maximum development in Ohio along the eastern edge of the state from Columbiana County south to Washington County. From central Columbiana County this series thins again to the north in the direction of Conneaut. The greatest thicknesses yet recorded in this state are 1,987 feet in the Reamer well located in West Township, Columbiana County, and 1,841 feet in the Knowlton well in Independence Township, Washington County." He further states that "the thickening of the Big Lime to the east is believed to occur chiefly in its middle portion."

A thickening of the Onondaga limestone at the top of the Big Lime sequence has been noted by E. E. Rehn.[10] The thickest belt of Onondaga limestone, as shown on his map, coincides with the thick Big Lime belt shown by Lamborn in Columbiana County.

Further evidence of a thickening of that part of the Big Lime that overlies the salt was noted by the present writer in cross sections and in the records of numerous wells in northeastern Ohio. This evidence is contingent on the assumption that the uppermost salt beds are of equivalent age over a wide area. If isolated beds of salt were deposited somewhat higher in the section than the average for other beds, there would be an apparent thinning of that part of the Big Lime above the salt. As an aid in testing this inference a map of the thickness of that part of the Big Lime above the salt series was constructed (fig. 3). The map brings out several striking features. Most noteworthy is the area of thick limestone trending slightly west of north from Columbiana County through Portage and Geauga Counties to Lake Erie. This belt approximates very closely the belt shown by Lamborn[11] in his thickness map of the Big Limestone sequence. East of the belt of thick lime the lime thins toward the Pennsylvania State line, and west of the belt the lime thins to a narrow area which extends from central Wayne County N. 25° W. across Medina County and into Lorain County. This area is enclosed by the 500-foot thickness contour on figure 3. West of the area enclosed

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[7]Martens, J. H. C. Rock salt deposits of West Virginia: West Virginia Geol. Survey Bull. 7, p. 15, 1943.

[8]Martens, J. H. C., idem, pp. 6–9.

[9]Lamborn, R. E., op. cit., pp. 353–355.

[10]Rehn, E. E. Onondaga group of parts of West Virginia and Virginia. Unpublished thesis, Ohio State University, 1942.

[11]Lamborn, R. E., op. cit., p. 354.

by the 500-foot contour the Devonian limestone and Bass Island dolomite increase in thickness to the western limit of the salt area. The interesting coincidence of the axis of the Parkersburg-Lorain syncline and the western edge of the thin area of Devonian limestone and Bass Island dolomite may be fortuitous or may indicate that the apparent westward thickening of the limestone is caused by the filling of a basin which was downwarped after the salt was deposited. If this

FIGURE 3. Map showing the variation in thickness of the rocks between the top of the Big Lime and the top of the uppermost salt bed. Contour interval 50 feet.

basin was present and a proportionately greater amount of limestone was deposited above the salt, then the thickness of the Big Lime which includes the limestones and dolomite above and the dolomites below the salt would be greater than the thickness of the Big Lime east of the basin. This is not true, however, for the

[13]Lamborn, R. E., op. cit., p. 354.

total thickness of the Big Lime is nearly the same as that shown on the thickness map by Lamborn,[12] which shows a gradual thickening of the Big Lime eastward. The thickening of the Devonian limestone and Bass Island dolomite above the salt may have been caused by subsequent erosion of the upper part of the salt section prior to the deposition of the Bass Island dolomite. Possibly, however, the apparent thickening is caused by the deposition of a salt bed low in the salt section and an absence of deposition of salt beds above at a later time.

When the thickness map of the upper Big Lime is compared with the thickness map of the combined salt beds, the areas of greatest thickness of each nearly coincide in Portage and Columbiana Counties. This relationship would seem to be reasonable proof that the deepest basin of deposition for the salt was likewise the deepest basin of deposition for the limestones above. The uppermost salt bed extends over a broad area and was deposited on an essentially flat surface.

THE LOCATION OF SALT PLANTS

The location of a salt plant depends largely upon the needs of the operator, who may desire a location near other chemical plants or along railroads that have the shortest haul to his markets. If the salt is not obtained by mining but is brought up as a brine from drilled wells, an adequate source of water is essential. Other factors permitting, the operator may desire the shallowest subsurface point in which he may obtain a maximum thickness of salt with a minimum of drilling.

A favorable area for prospecting for salt at a shallow depth lies in Lorain County. This area probably contains a sufficient thickness of salt in one bed to justify the cost of prospecting. If more than one bed of salt is required, then the areas of greatest salt thickness lying in Portage, Stark, and Tuscarawas Counties should be considered. Before a plant site is established and funds are expended for equipment and buildings, it would be prudent to make adequate core-drill tests of the salt series.

DESCRIPTION OF WELL SAMPLES BY R. E. LAMBORN

In the following records Lamborn has estimated the thickness of the salt beds from data derived from an examination of well cuttings. The writer made independent estimates of salt thicknesses from Lamborn's sample descriptions, and these estimates were in very close agreement with his. This agreement, however, may be a coincidence, for the determination of the thickness of a salt bed from well samples is at best an approximation. The thickness of a single salt bed was determined from an estimation of the percentage of salt fragments to other rock fragments in a sample taken at known depths, together with an estimation of the amount of salt taken into solution in the water used in drilling. Other factors considered were the size of the hole, the amount of water used in drilling, and the probable temperature of the water at the depth at which the sample was taken. Any of the factors used in determining the thickness of a salt bed from well cuttings may vary, and other and undeterminable factors may affect the calculations. For example, cavings from other formations, which may include higher salt beds, may change the percentage of salt to rock fragments in the sample, or the water used in drilling may be partly saturated by contact with salt from a bed higher in the hole. The estimated thicknesses of the salt beds have been added to the sample logs only as a possible aid to further prospecting. Samples taken by drill cores through the salt series will provide the only accurate means of determining the thickness of individual beds.

DESCRIPTIONS OF SAMPLES EXAMINED BY R. E. LAMBORN FROM SELECTED WELLS DRILLED THROUGH THE SALT

1. Ashtabula County — Saybrook Township — Lot 36
J. Q. Metcalf No. 1 — By Ohio Oil Company
Elevation 651 feet — Total depth 2930 feet — Completed in 1941
Located in Ashtabula quadrangle, 0.10 mile N. of 41° 50′ and 2.18 miles E. of 80° 55′

Depth (in feet) to Top	Bottom	*Description of sample*	*Estimated thickness of salt (feet)*
1370		Big Lime	
2052	2060	Rock salt, white	8
2060	2078	Rock salt, brownish	18
2078	2087	Dolomite, brown to gray, argillaceous	
2087	2096	Rock salt, brown	9
2096	2221	Dolomite, gray to bluish-gray, argillaceous, and dolomitic shales; some anhydrite	
2221	2234	Salt	13
2234	2255	Salt	21
2255	2268	20% salt; 80% shale	6
2268	2279	50% salt; 50% shale	8
2279	2288	Salt, nearly pure	9
2288	2304	Dolomitic shale and argillaceous dolomite with a few salt crystals	9
2304	2311	Shale, dark, and argillaceous dolomite; a few salt crystals	4
		Total	105

REMARKS: No salt observed in samples below depth of 2311 feet.

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2. Ashtabula County — Harpersfield Township — Lot 43
Breyley Bros. No. 1 — By Magnolia Petroleum Co.
Elevation 820 feet — Total depth 3341 feet — Completed in 1940
Located in Ashtabula quadrangle, 1.20 miles N. of 41° 45′ and 1.75 miles E. of 81° 00′

Depth (in feet) to Top	Bottom	*Description of sample*	*Estimated thickness of salt (feet)*
		Big Lime	
2200	2212	Dolomite, dark brown, impure, and dolomitic shale, trace of anhydrite	
2212	2230	Dolomite, dark brown, impure; a few percent of anhydrite and rock salt	9
2230	2250	Dolomite, brown; 25% salt and anhydrite	10
2250	2280	Rock salt, white	30
2280	2315	Dolomite, impure, and dolomitic shale; trace of anhydrite	
2315	2333	Dolomite, buff, porous, impure	
2362	2375	Dolomite, buff, porous, impure, and dolomitic shale	
2375	2385	Dolomite, brown, impure, and dolomitic shale; 30% rock salt	6
2385	2400	Dolomite, buff to brown, impure, a little anhydrite	
2400	2415	Same as above with 10% rock salt	9
2415	2464	Shale, brown to bluish-gray, dolomitic; trace of anhydrite	
2464	2477	Shale, greenish-gray, dolomitic, trace of brown impure dolomite and anhydrite	
2477	2552	Shale, greenish-gray and brown impure dolomite; trace of anhydrite	
2552	2569	Shale, light greenish-gray	
2569	2578	No sample	
2578	2600	Rock salt; a few fragments of dolomite	22
2600	2610	Rock salt	10
2610	2630	Dolomite, brown, dense; 5% anhydrite and rock salt	9
		Total	105

REMARKS: No salt observed in samples from greater depths in this well.

3. Ashtabula County — Richmond Township — Lot 15
Hatton Brothers No. 1 — By Ohio Oil Company
Elevation 1049 feet — Total depth 3841 feet — Completed in 1941
Located in Andover quadrangle, 3.55 miles S. of 41° 45′ and 3.74 miles W. of 80° 55′

Depth (in feet) to Top	Bottom	*Description of sample*	*Estimated thickness of salt (feet)*
2235		Big Lime	
2905	2928	Chiefly rock salt; a little dolomite	21
2928	2980	Shale, soft, bluish-gray, dolomitic, with anhydrite	
2980	3000	Limestone, light bluish-gray, dolomitic; no anhydrite	
3000	3049	Dark, bluish-gray, impure gypsiferous rock	
3049	3057	Dark-gray impure gypsiferous rock mass, caked by salt	3
3057	3135	Bluish-gray, gypsiferous rock with 5% to 10% rock salt	39
3135	3155	Dark bluish-gray, gypsiferous rock with a few salt crystals	5
		Total	68

REMARKS: No salt observed in samples at greater depths.

4. Lake County — Kirtland Township — Lot 90
F. O. Andrews No. 1 — By East Ohio Gas Company
Elevation 1090 feet (topographic map) — Total depth 3756 feet — Completed in 1940
Located in Mentor quadrangle, 0.25 mile S. of 41° 35′ and 1.00 mile W. of 81° 20′

Depth (in feet) to Top	Bottom	*Description of sample*	*Estimated thickness of salt (feet)*
1791		Big Lime	
*2523	2549	Dolomite, brown, impure, argillaceous, with anhydrite; 5% rock salt	13
2549	2561	Dolomite, brown, impure, with a small amount of anhydrite	
2561	2576	Rock salt	15
2576	2586	Dolomite, brown, impure; some anhydrite and rock salt	5
2586	2594	Dolomite, light-brown, impure, porous; with anhydrite	
2594	2602	Dolomite, light-brown, impure, porous; some crusting of salt	3
2602	2612	Dolomite, brown; 75% salt crystals	9
2612	2642	Dolomite, brown; 50% salt crystals	21
2642	2788	Dolomite, brown, argillaceous, with anhydrite	
2788	2797	Dolomite, brown, impure, argillaceous; 15% salt; some anhydrite	5
2797	2811	Dolomite, brown, impure, argillaceous; some anhydrite; 30% salt	7
2811	2855	Dolomite, brownish, argillaceous; some greenish-gray shale	
2855	2947	Same, with anhydrite	
2947	2960	Dolomite, brown, impure; 2% salt crystals	8
2960	2969	Dolomite, brown, impure; some salt and anhydrite	5
		Total	91

*Top of uppermost salt bed recorded by driller at 2534 feet.

5. Trumbull County — Lordstown Township — Lot 20
John Giovannone No. 1 — Magnolia Petroleum Company
Elevation 960 feet (topographic map) — Total depth 4824 feet — Completed in 1941
Located in Warren quadrangle, 1.0 mile S. of 41° 10′ and 0.40 mile W. of 80° 50′

Depth (in feet) to Top	Bottom	*Description of sample*	*Estimated thickness of salt (feet)*
2785		Big Lime	
3407	3422	Dolomite, dark bluish-gray and brown, argillaceous and gypsiferous, caked by salt	6
3422	3462	Dolomite, brown, impure, with some salt crystals	18
3462	3477	Dolomite, light-brown, impure, argillaceous, with anhydrite	
3477	3503	Same as above, with salt crystals	10
3503	3600	Dolomite, brown, argillaceous, much anhydrite	
3600	3612	Dolomite, brown, impure, porous, with anhydrite	

3612	3640	Dolomite, brown, porous, impure, with some salt	13
3640	3808	Dolomite, brown, dense, impure, argillaceous; with anhydrite	
3808	3838	Dolomite, brown, argillaceous, porous; with anhydrite	
3838	3862	Dolomite, with rock salt and anhydrite	14
		Total	61

REMARKS: No salt observed at greater depths.

6. Mahoning County — Smith Township — Section 4
T. S. Schrum No. 1 — By Magnolia Petroleum Company
Elevation 1064 feet — Total depth 5021 feet — Completed in 1941
Located in Alliance quadrangle, 1.7 miles S. of 41° 00′ and 2.78 miles W. of 81° 00′

Depth (in feet) Top	Bottom	Description of sample	Estimated thickness of salt (feet)
2824		Big Lime	
3555	3570	Dolomite, impure; 85% salt crystals	13
3570	3607	Salt crystals	37
3607	3632	Dolomite, buff, argillaceous, with anhydrite	
3632	3680	Dolomite, buff, argillaceous; 5% rock salt	20
3680	3780	Dolomite, buff, argillaceous; trace of anhydrite	
3780	3815	Dolomite, buff, argillaceous; 10% salt crusts	10
3815	3820	Dolomite, buff to gray-black; trace of anhydrite	
3820	3835	No sample	
3835	3881	Dolomite, buff, argillaceous; 70% salt crusts	18
3881	3945	Dolomite, buff, dense, argillaceous; trace of anhydrite	
3945	3983	Dolomite, deep-buff and brown; argillaceous; 5% to 10% salt	15
3983	4044	Dolomite, dark-gray to buff, dense texture, argillaceous; trace of anhydrite	
4044	4062	Dolomite, gray to buff, argillaceous; 5% salt crusts	7
		Total	120

REMARKS: No salt observed at greater depths.

7. Stark County — Lake Township — Section 34
Jacob Hyler et al No. 1 — C. W. White
Elevation 1150 feet — Total depth 4584 feet — Completed in 1939
Located in Canton quadrangle, 0.80 mile S. of 40° 55′, and 1.35 miles W. of 81° 20′

Depth (in feet) Top	Bottom	Description of sample	Estimated thickness of salt (feet)
2765		Big Lime	
3372	3382	Dolomite, brown, dense, with anhydrite	
3382	3391	Dolomite, brown, dense, with anhydrite; some salt crystals	5
3391	3402	Dolomite, buff, dense, 5% anhydrite	
3402	3413	Dolomite, buff, dense, 5% anhydrite, a little rock salt	5
3413	3436	Dolomite, buff, dense, with anhydrite	
3436	3448	Dolomite, buff, dense, with anhydrite; 50% rock salt	8
3448	3484	Rock salt, almost pure	36
3484	3495	Dolomite, buff, dense, with 50% anhydrite	
3495	3505	20% anhydrite and dolomite; 80% rock salt	10
3505	3515	Dolomite 50%; rock salt 50%	7
3515	3535	Dolomite, buff, 50%; some anhydrite and shale	
3550	3568	Dolomite, brown, dense, a little anhydrite and salt	9
3568	3578	Dolomite 50%; anhydrite and salt 50%	6
3578	3589	Dolomite 60%; anhydrite and salt 40%	6
3589	3600	Dolomite, buff; a little anhydrite and dark shaly dolomite	
3600	3690	Dolomite, buff, dense, small amount of anhydrite	
3600	3756	No salt recognized	
3690	3756	Dolomite, buff, impure, porous; trace of anhydrite	
3756	3766	Dolomite, buff, porous; some anhydrite, salt, and shale	4
3766	3778	Same as above, 50% salt and shale	5
3778	3790	Chiefly rock salt	12
		Total	113

REMARKS: No salt observed in samples at greater depth from this well.

8. Stark County — Sugar Creek Township — Section 34
M. Kaylor No. 1 — By Ohio Oil Company
Elevation 1005 feet — Total depth 4368 feet — Completed in 1943
Located in Navarre quadrangle, 1.55 miles S. of 40° 40′ and 0.85 mile W. of 81° 35′

Depth (in feet) to Top	Bottom	*Description of sample*	*Estimated thickness of salt (feet)*
2637		Big Lime	
3207	3264	Dolomite, buff, argillaceous; some anhydrite	
3264	3280	Dolomite, buff, argillaceous; some anhydrite; a few salt crystals	9
3280	3304	Rock salt	24
		Total	33

REMARKS: No salt recognized at greater depths in this well.

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9. Tuscarawas County — Franklin Township — Section 9
George Smith No. 1 — By Columbian Carbon Company
Elevation 935.6 feet — Total depth 4477 feet — Completed in 1941
Located in Navarre quadrangle, 1.45 miles S. of 40° 35′ and 2.10 miles W. of 81° 30′

Depth (in feet) to Top	Bottom	*Description of sample*	*Estimated thickness of salt (feet)*
2859		Big Lime	
3498	3532	Rock salt 85%; 15% brown, impure dolomite	32
3532	3600	Dolomite, buff and brown, impure; with some shale; trace of anhydrite	
3600	3658	75% salt; 25% brown, impure dolomitic rock	49
3658	3666	Dolomite, buff, impure; trace of anhydrite	
3666	3675	Dolomite, buff to brown, porous; trace of anhydrite	
3675	3700	50% rock salt; 50% buff, impure dolomite and gypsiferous shale	17
		Total	98

REMARKS: No salt recognized at greater depths.

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10. Tuscarawas County — Dover Township — Lot 30
Robinson Clay Products Co. No. 3 — By Brendel Producing Company
Elevation 900 feet (topographic map) — Total depth 4623 feet — Completed in 1940
Located in Navarre quadrangle, 1.15 miles S. of 40° 35′ and 0.20 mile W. of 81° 30′

Depth (in feet) to Top	Bottom	*Description of sample*	*Estimated thickness of salt (feet)*
2863		Big Lime	
3482	3490	Dolomite, buff, dense, with rock salt	5
3490	3502	Same as above; 60% rock salt	9
3502	3514	Dolomite, buff; some anhydrite with rock salt	5
3514	3529	Dolomite, buff; a little anhydrite	
3529	3545	Same as above; much rock salt	5
3545	3554	Dolomite, buff; porous, trace of anhydrite	
3554	3566	Dolomite, buff to brown, shaly; trace of anhydrite	
3566	3608	Dolomite, dark brown, dense texture; trace of anhydrite	
3608	3623	Chiefly rock salt; a little brown dolomite and anhydrite	15
3623	3638	Chiefly rock salt; a little brown dolomite and anhydrite	15
		Total	54

REMARKS: No salt recognized at lower levels in this well.

11. Carroll County — Monroe Township — Section 9
S. W. Tipton et al No. 1 — By Brendel Producing Company
Elevation 948 feet — Total depth 5496 feet — Completed in 1941
Located in Carrollton quadrangle, 4.55 miles S. of 40° 35′ and 3.4 miles W. of 81° 10′

Depth (in feet) to		Description of sample	Estimated thickness of salt (feet)
Top	Bottom		
3540		Big Lime	
4130	4140	Rock salt, nearly pure	10
4140	4200	Dolomite, gray to dark-drab, argillaceous	
4200	4230	Same as above with 10% salt crusts	11
4230	4285	Dolomite, deep-buff to light-brown, dense, argillaceous	
4285	4290	Same as above, with 5% salt crusts	2
4290	4400	Dolomite, gray to dark-brown, dense, argillaceous	
4400	4405	No sample	
4405	4420	Dolomite, gray to dark-brown, dense, argillaceous; 20% salt cake	7
4420	4460	Dolomite, buff, dense, argillaceous	
4460	4470	Same as above; 5% salt cake	3
4470	4490	Dolomite, brown to buff, dense, argillaceous	
4490	4520	Same as above; with 50% salt crystals	22
4520	4540	Dolomite, brown, argillaceous; trace of salt	
		Total	55

Remarks: No salt recognized at greater depths in this well.

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12. Tuscarawas County — Clay Township — Section 22
Benjamin J. Carrothers No. 1 — By Ohio Fuel Gas Company
Elevation 1144.9 feet — Total depth 5289 feet — Completed in 1936
Located in Uhrichsville quadrangle, 1.92 miles S. of 40° 20′ and 2.58 miles W. of 81° 25′

Depth (in feet) to		Description of sample	Estimated thickness of salt (feet)
Top	Bottom		
3504		Big Lime	
4375	4390	Dolomite, brown; a little anhydrite; 20% rock salt	12
4390	4401	Same as above, small amount of rock salt	5
		Total	17

Remarks: No salt recognized at lower levels in this well.

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13. Harrison County — Stock Township — Section 32
E. A. Mizer No. 1 — By The Texas Company
Elevation 926 feet — Total depth 6301 feet — Completed in 1945
Located in Scio quadrangle, 1.40 miles S. of 40° 20′ and 0.75 mile W. of 81° 05′

Depth (in feet) to		Description of sample	Estimated thickness of salt (feet)
Top	Bottom		
4121		Big Lime	
4764	4802	Rock salt; 5% brown impure dolomite	35
4802	4826	Rock salt	24
4826	4859	Dolomite, gray to brown, argillaceous, with anhydrite	
4859	4894	Dolomite, buff to dark-brown, argillaceous, with salt cake	13
4894	4907	Dolomite, gray to gray-brown, dense, argillaceous, trace of anhydrite	
4907	4940	Dolomite, gray to brown, dense, argillaceous, some anhydrite; a few salt crystals	14
4940	4967	Same as above	11
4967	5002	Same as above	14
5002	5121	Dolomite, brown, dense, argillaceous, parts shaly; trace of anhydrite	

5121	5145	Rock salt, white; 3% impure dolomite	24
5145	5172	Rock salt 60%; 40% argillaceous dolomite	22
5172	5194	Shale, soft, brown; with anhydrite	
5194	5221	Dolomite, brown, argillaceous, trace of anhydrite	
5221	5276	Dolomite, brown, argillaceous, shaly; a few salt crystals; trace of anhydrite	26
5276	5287	Dolomite, brown; argillaceous, shaly; trace of anhydrite	
5287	5304	Dolomite, gray to light-buff, argillaceous; a few salt crystals	8
		Total	191

REMARKS: No salt recognized at greater depths in this well.

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14. Harrison County — Washington Township — Section 2
W. H. Blackwell No. 1 — By Ohio Oil Company
Elevation 1135 feet — Total depth 6255 feet — Completed in 1941
Located in Flushing quadrangle, 1.10 miles S. of 40° 15′ and 0.65 mile E. of 81° 15′

Depth (in feet) to			*Estimated thickness of salt (feet)*
Top	*Bottom*	*Description of sample*	
4230		Big Lime	
4836	4856	Salt, gray to buff; small percent of dolomite	20
4856	4865	Rock salt, nearly pure	9
		Total	29

REMARKS: No salt recognized at greater depths in this well; no salt recognized in samples above depth 4836.

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15. Belmont County — Smith Township — Section 19
T. H. Mobley — Natural Gas Company of West Virginia
Elevation 1174 feet — Total depth 7887 feet — Completed in 1940
Located in Clarington quadrangle, 3.35 miles S. of 40° 00′ and 2.50 miles W. of 80° 55′

Depth (in feet) to			*Estimated thickness of salt (feet)*
Top	*Bottom*	*Description of sample*	
5451		Big Lime	
6231	6254	Dolomite, dark-bluish, impure; sample encrusted with salt	7
6254	6313	Same as above with larger percent of rock salt	23
6313	6345	Dolomite, brown, impure, with a trace of salt	13
6345	6464	Dolomite, dark-brown, impure, and dolomitic shale; much anhydrite	
6464	6625	Dolomite, buff, impure, and dark dolomitic shale; much anhydrite	
6625	6647	Dolomite, dark brown, impure; some anhydrite; salt encrusted	7
6647	6655	Dolomite, light brown; dark brown dolomitic shale; some anhydrite	
6655	6662	Same as above; caked with salt	
6662	6687	Dolomitic shale, brown, gypsiferous, with some salt	10
6687	6695	Same, salt encrusted	3
6695	6701	Shales, buff, with anhydrite and some salt crusts	
6701	6809	Dolomite, buff, impure, and dolomitic shale; somewhat encrusted with salt	2
		Total	65